Automatic inspection of satsuma slices using a machine vision system

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1. Introduction

Spain is one of the most important producer and exporter of fresh fruit in the world. Part of the Spanish production is commercialised as canned fruit, which represent 7.5% of the food industry and a market of about 4.200 million euros. However, the recent presence in the market of third countries with much lower production costs has reduced the Spanish canned fruit exports to the European Union in 50% in the last four years.

This problem is particularly important in the case of satsuma slices, where only a few producers remain in Spain. A complete automation of the whole process is the only way for these enterprises to survive. Although most of the tasks have already been automated, the visual inspection at the end of the line is still performed by operators that separate manually the fruit in commercial categories.

This work focuses on the development of an automatic system, based on artificial vision, for the inspection and classification of Satsuma slices on line. The system should be capable to reach a production of 0.5 tonnes/h, equivalent to inspect about 28 slices/s.

2. Objective

To develop image analysis algorithms for the automatic inspection and classification in real time of satsuma slices into commercial qualities. The system should be capable of detecting slices containing seeds, broken slices and also to identify raw material as small pieces of skin or leafs.

3. Material and Methods

The satsuma slices used to perform the analysis have been collected by experts at the end of one canning line at Agriconsa, S.A. company. The slices have been divided in three categories: good, broken slices and slices containing seeds.

The vision system was composed by two cameras (JAI CVM77) connected to a frame grabber (Imaging Technology PCRGB) plugged in a personal computer, based on Pentium IV processor and Windows XP as operating system.

The fruit circulates under the camera on semi-transparent conveyor belts that allow the backlighting of the slices. This way, the slice appears translucent in the images with a dark area corresponding to the seed if present.

Primarily, the developed algorithm used histogram based techniques to detect these darker areas. The main problem of this method was that the bigger slices also presented darker areas in the images because of their thickness, consequently other techniques, as region oriented segmentation, have been implemented.

To detect the broken slices, combinations of simple morphological parameters as perimeter, area, circularity or length showed to be precise and fast enough for real time requirements. The algorithms have been implemented using the MS Windows API (advanced programming interface) and tested by means of a sorting prototype.

4. Results

Figure 1 shows a scene taken by the camera, while figure 2 shows the segmented images upon which the sorting decision is taken.

After the first tests the system was capable of detecting 80% of the slices that contained seeds and 70% of broken slices, working at speed of 80 cm/s. Further work is currently undergoing to improve these results.

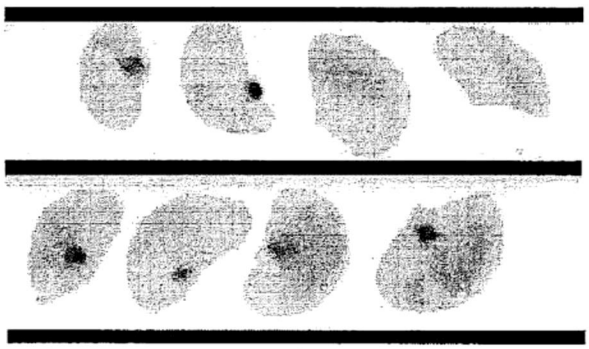

Figure 1. Scene with broken slices and slices that contain seeds

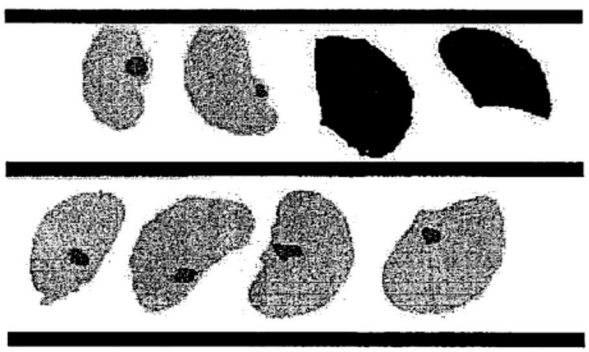

Figure 2. Segmented image representing the skin, the seeds and the broken slices.

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